



US008493183B2

(12) **United States Patent**
Yamagajp et al.

(10) **Patent No.:** **US 8,493,183 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **WIRELESS TAG AND METHOD FOR PRODUCING WIRELESS TAG**

340/572.5, 505, 568, 572; 343/764, 866, 343/730, 803, 846, 725, 741, 728, 732, 853, 343/855; 235/375, 385, 435, 492; 455/562.1, 455/575.7, 83, 562

(75) Inventors: **Takashi Yamagajp**, Kawasaki (JP);
Toru Maniwa, Kawasaki (JP)

See application file for complete search history.

(73) Assignee: **Fujitsu Limited**, Kawasaki (JP)

(56) **References Cited**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 876 days.

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(22) Filed: **Dec. 29, 2009**

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(65) **Prior Publication Data**

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Related U.S. Application Data

(Continued)

(63) Continuation of application No. PCT/JP2007/064138, filed on Jul. 18, 2007.

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(51) **Int. Cl.**

European Office Action dated Dec. 2, 2010 in application No. 07790893.7.

- H04Q 5/22** (2006.01)
- G08B 13/14** (2006.01)
- G08B 23/00** (2006.01)
- G08B 21/00** (2006.01)
- H01Q 1/00** (2006.01)
- H01Q 7/00** (2006.01)
- H01Q 11/02** (2006.01)
- H01Q 3/00** (2006.01)
- H01Q 7/04** (2006.01)
- G06K 19/06** (2006.01)

(Continued)

Primary Examiner — Jennifer Mehmood

Assistant Examiner — Mirza Alam

(74) *Attorney, Agent, or Firm* — Smith, Gambrell & Russell, LLP

(52) **U.S. Cl.**

USPC **340/10.1**; 340/572.7; 340/573.1; 340/651; 343/730; 343/866; 343/803; 343/732; 343/748; 343/764; 343/842; 235/492

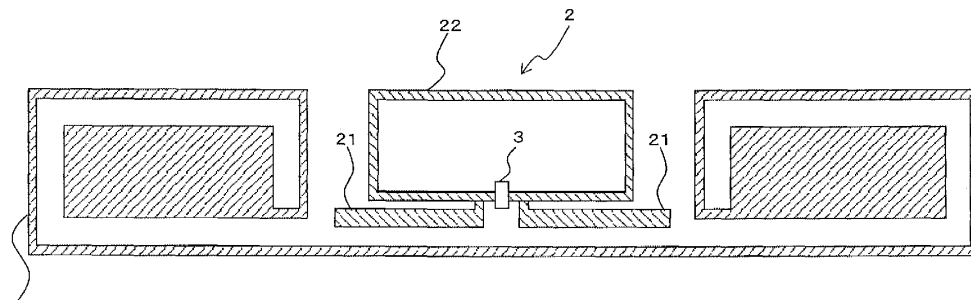
(57) **ABSTRACT**

The wireless tag includes an antenna conductor; a first power-supply conductor which is electromagnetic-inductively coupled with the antenna conductor; and a second power-supply conductor which is loop-shaped and which is electrically coupled with the first power-supply conductor.

(58) **Field of Classification Search**

USPC 340/10.1, 572.1, 572.7, 572.8, 10.2,

10 Claims, 16 Drawing Sheets



1: ANTENNA PATTERN



US008493215B2

(12) **United States Patent**
Tada

(10) **Patent No.:** **US 8,493,215 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **COMMUNICATION ANTENNA, RFID TAG, NON-CONTACT COMMUNICATION DEVICE, AND NON-CONTACT COMMUNICATION METHOD**

(75) Inventor: **Nobuyuki Tada**, Kanagawa (JP)

(73) Assignee: **FUJIFILM Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 585 days.

(21) Appl. No.: **12/641,331**

(22) Filed: **Dec. 18, 2009**

(65) **Prior Publication Data**

US 2010/0164726 A1 Jul. 1, 2010

(30) **Foreign Application Priority Data**

Dec. 26, 2008 (JP) 2008-334495

(51) **Int. Cl.**
G08B 13/14 (2006.01)

(52) **U.S. Cl.**
USPC **340/572.7; 343/803**

(58) **Field of Classification Search**
USPC 340/572.7, 572.6, 572.8, 568.1;
343/725-730, 793, 795, 803
See application file for complete search history.

(56) **References Cited**

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Partial English language translation of the following: Office action dated Oct. 2, 2012 from the Japanese Patent Office in a Japanese patent application corresponding to the instant patent application. This office action translation is submitted now in order to supplement the understanding of patent document JP 2005-278139 which is cited in the office action and is being disclosed in the instant Information Disclosure Statement.

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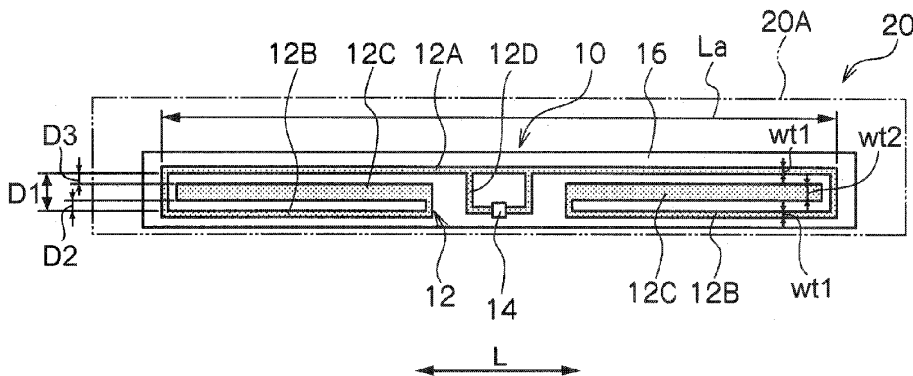
Primary Examiner — John A Tweel, Jr.

(74) Attorney, Agent, or Firm — SOLARIS Intellectual Property Group, PLLC

(57) **ABSTRACT**

A communication antenna has a rectangular radiating section, and has a structure that emits an electric field of linear polarized waves only in a vicinity of the radiating section of the antenna. An RFID tag has an IC chip and a tag antenna that is long in a predetermined direction. The tag antenna has a main antenna portion that is rectilinear and extends over substantially an entire length in a longitudinal direction of the tag antenna, and folded-over antenna portions at which currents induced by an external electric field offset one another due to portions that extend in mutually different orientations in the longitudinal direction. A parallel interval between the main antenna portion and a first folded-over antenna portion exceeds a width of the radiating section of the communication antenna.

8 Claims, 16 Drawing Sheets





US008493269B2

(12) **United States Patent**
Jang et al.

(10) **Patent No.:** **US 8,493,269 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **MAGNETODIELECTRIC SUBSTRATE AND ANTENNA APPARATUS USING THE SAME**

(75) Inventors: **Soo-Yong Jang**, Daegu (KR); **Austin Kim**, Gyeonggi-do (KR); **Jae-Ho Lee**, Gyeonggi-do (KR); **Young-Soon Lee**, Gyeongbuk (KR); **Ui-Jung Kim**, Gyeongbuk (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 407 days.

(21) Appl. No.: **12/878,268**

(22) Filed: **Sep. 9, 2010**

(65) **Prior Publication Data**
US 2011/0068991 A1 Mar. 24, 2011

(30) **Foreign Application Priority Data**
Sep. 23, 2009 (KR) 10-2009-0089954

(51) **Int. Cl.**
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
USPC 343/700 MS; 343/702; 343/787

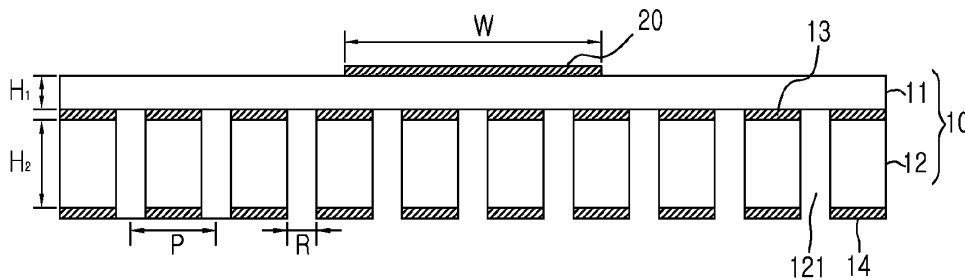
(58) **Field of Classification Search**
USPC 343/702, 700 MS, 787
See application file for complete search history.

(56) **References Cited**
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Primary Examiner — Dieu H Duong
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(57) **ABSTRACT**
A magnetodielectric substrate includes a first dielectric layer, a second dielectric layer, conductive patterns, and a plurality of air vias. The first dielectric layer has a predetermined height, and the second dielectric layer is stacked on the first dielectric layer. Conductive patterns are coated on an upper surface and a lower surface of one of the first and second dielectric layers. A plurality of air vias is formed with a predetermined diameter and a predetermined interval such that they pass through up to the conductive patterns of the upper and lower surfaces from the dielectric layer on which the conductive patterns are coated.

15 Claims, 9 Drawing Sheets





US008493274B2

(12) **United States Patent**
Raura

(10) **Patent No.:** **US 8,493,274 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

(54) **SLOT ANTENNA AND PORTABLE WIRELESS TERMINAL**

375/267; 342/368; 235/380; 370/329, 335, 370/280; 455/550.1, 452.2; 439/108

See application file for complete search history.

(75) Inventor: **Toru Raura**, Tokyo (JP)

(56) **References Cited**

(73) Assignee: **NEC Corporation**, Tokyo (JP)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 195 days.

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(22) PCT Filed: **Nov. 16, 2006**

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(86) PCT No.: **PCT/JP2006/322807**

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(2), (4) Date: **May 19, 2008**

International Search Report PCT/ISA/210 of PCT/JP2006/322807.

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(87) PCT Pub. No.: **WO2007/058230**

Primary Examiner — Robert Karacsony

PCT Pub. Date: **May 24, 2007**

Assistant Examiner — Hasan Islam

(65) **Prior Publication Data**

US 2009/0231215 A1 Sep. 17, 2009

(74) *Attorney, Agent, or Firm* — Young & Thompson

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Nov. 18, 2005 (JP) 2005-334952
Sep. 21, 2006 (JP) 2006-256304
Sep. 21, 2006 (JP) 2006-256305

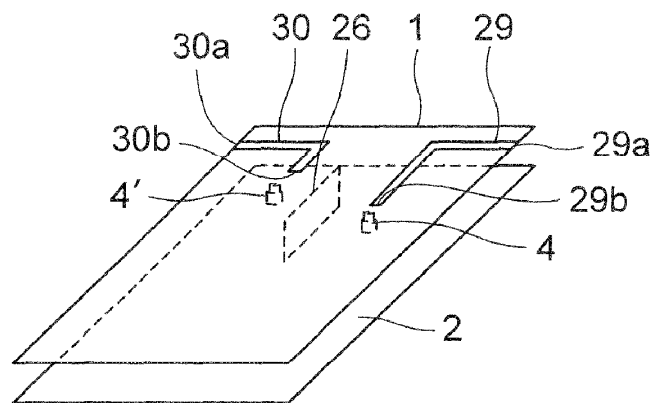
A slot antenna is provided with at least two conductive plates arranged to face each other. A slot is arranged on one of or both of the facing conductive plates and has a long and narrow opening shape. A power feeding unit is arranged between the facing conductive plates and is electrically and physically connected with the facing conductive plates, respectively. When power is fed to the power feeding unit, the power is fed between the facing conductive plates by the power feeding unit. Thus, excitation with a frequency dependent on the electrical length of the slot is induced at the slot, and a current excited at the slot is distributed entirely over one conductive plate, the current becomes a radiation source, and an electromagnetic wave is radiated from the one conductive plate. At this time, the other conductive plate operates as the reflecting plate of the electromagnetic wave.

17 Claims, 49 Drawing Sheets

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
USPC **343/767**; 343/702; 343/770

(58) **Field of Classification Search**
USPC 343/727, 768, 840, 906, 713, 880,
343/911 R, 873, 702, 767, 700 MS, 770;





US008493279B2

(12) **United States Patent**
Pera et al.

(10) **Patent No.:** **US 8,493,279 B2**

(45) **Date of Patent:** **Jul. 23, 2013**

(54) **ANTENNA FEED SYSTEM**

(75) Inventors: **Robert J. Pera**, San Jose, CA (US);
John R. Sanford, Encinitas, CA (US)

(73) Assignee: **Ubiquiti Networks, Inc.**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 180 days.

(21) Appl. No.: **12/477,986**

(22) Filed: **Jun. 4, 2009**

(65) **Prior Publication Data**
US 2010/0309085 A1 Dec. 9, 2010

(51) **Int. Cl.**
H01Q 19/12 (2006.01)
H01Q 19/10 (2006.01)

(52) **U.S. Cl.**
USPC **343/840; 343/833; 343/834**

(58) **Field of Classification Search**
USPC 343/840, 833, 834, 779, 786, 757,
343/761, 754, 758, 795, 837, 781 P, 781 R,
343/781 CA; 455/90.3

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Michael C Wimer

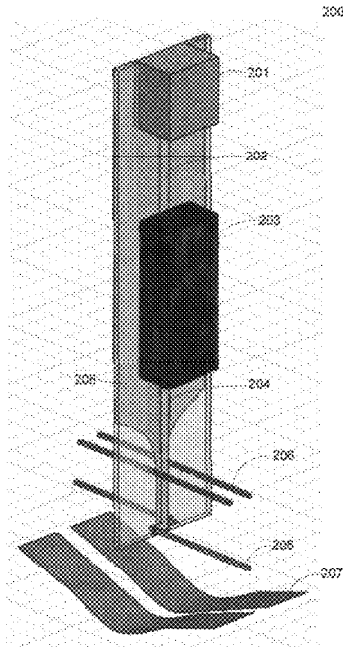
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Anteco & Tormey LLP, Peter Tormey

(57) **ABSTRACT**

A microwave system comprises an antenna, antenna feed, a radio transceiver, and appropriate cabling among the aforementioned. Cost, performance and reliability improvements are achieved with further integration of these elements and with design improvements in the antenna feed. One improvement is the integration of the radio transceiver with the antenna feed. This improvement has many benefits including the to elimination of RF cables and connectors. Another improvement is the incorporation of parasitic radiators and sub-reflectors as part to of the antenna feed. The entire antenna, including the feed design is optimized with 3D finite element method (FEM) software and numerical optimization software. Another improvement is the utilization of the digital cable to power the integrated radio transceiver and a center fed parabolic reflector.

10 Claims, 7 Drawing Sheets





US008493280B2

(12) **United States Patent**
Soler Castany et al.

(10) **Patent No.:** **US 8,493,280 B2**
(45) **Date of Patent:** **Jul. 23, 2013**

- (54) **ANTENNA STRUCTURE FOR A WIRELESS DEVICE WITH A GROUND PLANE SHAPED AS A LOOP**
- (75) Inventors: **Jordi Soler Castany**, Barcelona (ES);
Carlos Puente Baliarda, Barcelona (ES)
- (73) Assignee: **Fractus, S.A.**, Barcelona (ES)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/282,767**

(22) Filed: **Oct. 27, 2011**

(65) **Prior Publication Data**
US 2012/0038536 A1 Feb. 16, 2012

Related U.S. Application Data

- (63) Continuation of application No. 12/834,177, filed on Jul. 12, 2010, now Pat. No. 8,077,110, which is a continuation of application No. 11/719,151, filed as application No. PCT/EP2005/055959 on Nov. 14, 2005, now Pat. No. 7,782,269.
- (60) Provisional application No. 60/627,653, filed on Nov. 12, 2004.
- (51) **Int. Cl.**
H01Q 1/48 (2006.01)
- (52) **U.S. Cl.**
USPC **343/846**
- (58) **Field of Classification Search**
USPC 343/700 MS, 702, 846, 848
See application file for complete search history.

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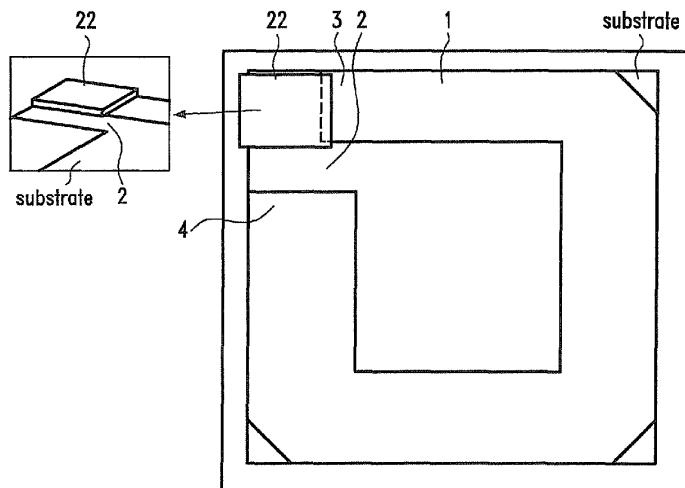
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Kenyon & Kenyon LLP

(57) **ABSTRACT**

This invention refers to an antenna structure for a wireless device comprising a ground plane and an antenna element, wherein the ground plane has the shape of an open loop. The invention further refers to an antenna structure for a wireless device, such as a light switch or a wrist sensor or wristwatch, comprising an open loop ground plane having a first end portion and a second end portion, the open loop ground plane defining an opening between the first end portion and the second end portion; and an antenna component positioned within the opening defined between the first end portion and the second end portion and overlapping at least one of the first end portion or the second end portion. Further the invention refers to a corresponding wireless device and to a method for integrating such an antenna structure in a wireless device.

20 Claims, 21 Drawing Sheets





US008497806B2

(12) **United States Patent**
Lai et al.

(10) **Patent No.:** **US 8,497,806 B2**
(45) **Date of Patent:** **Jul. 30, 2013**

(54) **MOBILE WIRELESS DEVICE WITH MULTI-BAND LOOP ANTENNA WITH ARMS DEFINING A SLOTTED OPENING AND RELATED METHODS**

(75) Inventors: **Chun Kit Lai**, Sunrise, FL (US); **Soo Liam Ooi**, Sunrise, FL (US); **Qiwu Tan**, Sunrise, FL (US)

(73) Assignee: **Research In Motion Limited**, Waterloo, Ontario (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 361 days.

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Primary Examiner **Trinh Dinh**

(74) *Attorney, Agent, or Firm* — **Allen, Dycer, Doppelt, Milbrath & Gilchrist, P.A.**

(21) Appl. No.: **13/005,326**

(22) Filed: **Jan. 12, 2011**

(65) **Prior Publication Data**

US 2012/0019421 A1 Jan. 26, 2012

Related U.S. Application Data

(60) Provisional application No. 61/367,083, filed on Jul. 23, 2010.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/00 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
USPC **343/702**; 343/729; 343/700 MS

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

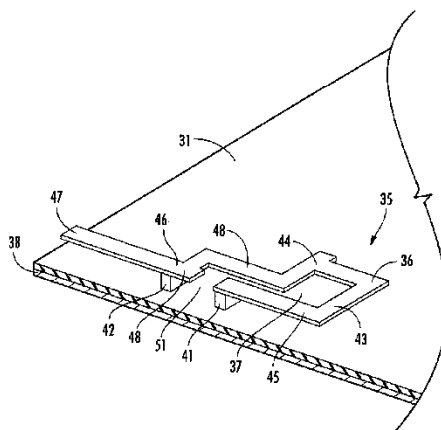
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(57) **ABSTRACT**

A mobile wireless communications device may include a housing, a printed circuit board (PCB) carried by the housing. The device may also include an antenna coupled to wireless transceiver circuitry carried by the PCB. The antenna may include first and second feed legs extending upwardly from the PCB, a loop conductor spaced above the PCB and having a gap therein defining first and second ends, and a first conductor arm spaced above the PCB and extending between the first feed leg and the first end. The antenna may further include a second conductor arm spaced above the PCB and having a proximal portion between the second feed leg and the second end, and having a distal portion extending outwardly from the second feed leg. The first conductor arm and the proximal portion may define a slotted opening into an interior of the loop conductor.

23 Claims, 9 Drawing Sheets





US008497808B2

(12) **United States Patent**
Wang

(10) **Patent No.:** **US 8,497,808 B2**
(45) **Date of Patent:** **Jul. 30, 2013**

(54) **ULTRA-WIDEBAND MINIATURIZED OMNIDIRECTIONAL ANTENNAS VIA MULTI-MODE THREE-DIMENSIONAL (3-D) TRAVELING-WAVE (TW)**

(75) Inventor: **Johnson J. H. Wang**, Marietta, GA (US)

(73) Assignee: **Wang Electro-Opto Corporation**, Marietta, GA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 292 days.

(21) Appl. No.: **13/082,744**

(22) Filed: **Apr. 8, 2011**

(65) **Prior Publication Data**
US 2012/0256799 A1 Oct. 11, 2012

(51) **Int. Cl.**
H01Q 11/02 (2006.01)

(52) **U.S. Cl.**
USPC **343/737**; 343/834

(58) **Field of Classification Search**
USPC 343/737, 729, 834, 846
See application file for complete search history.

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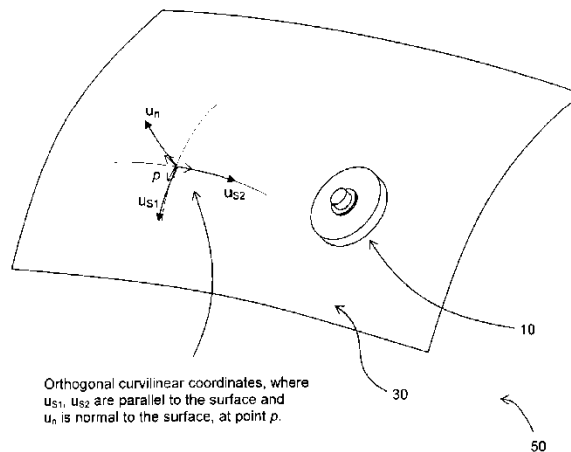
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Primary Examiner — Ahshik Kim
(74) *Attorney, Agent, or Firm* — Thomas | Horstemeyer, LLP

(57) **ABSTRACT**

A class of ultra-wideband miniaturized traveling-wave (TW) antennas comprising a conducting ground surface at the base, a plurality of TW structures having at least one ultra-wideband low-profile two-dimensional (2-D) surface-mode TW structure, a frequency-selective coupler placed between adjacent TW structures, and a feed network. In one embodiment, a 2-D surface-mode TW structure is positioned above the conducting ground surface, a normal-mode TW structure placed on top with an external frequency-selective coupler placed in between; continuous octaval bandwidth of 14:1 and size reduction by a factor of 3 to 5 are achievable. In other embodiments using at least two 2-D TW structures and a dual-band feed network, a continuous bandwidth over 100:1, and up to 140:1 or more, is reachable. In yet another embodiment, ultra-wideband multi-band performance over an octaval operating bandwidth up to 2000:1 or more is feasible.

24 Claims, 13 Drawing Sheets





US008498182B1

(12) **United States Patent**
Balamane et al.

(10) **Patent No.:** **US 8,498,182 B1**
(45) **Date of Patent:** **Jul. 30, 2013**

(54) **WRAP-AROUND ANTENNA DESIGN FOR IMPROVED PERFORMANCE IN THERMALLY-ASSISTED MAGNETIC RECORDING**

(75) Inventors: **Hamid Balamane**, Portola Valley, CA (US); **Jordan A. Katine**, Mountain View, CA (US); **Neil L. Robertson**, Palo Alto, CA (US); **Matteo Staffaroni**, Pleasanton, CA (US); **Barry C. Stipe**, San Jose, CA (US)

(73) Assignee: **HGST Netherlands B.V.**, Amsterdam (NL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/490,283**

(22) Filed: **Jun. 6, 2012**

(51) **Int. Cl.**
G11B 11/00 (2006.01)

(52) **U.S. Cl.**
USPC **369/13.33**; 369/13.2; 369/13.02; 360/59

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

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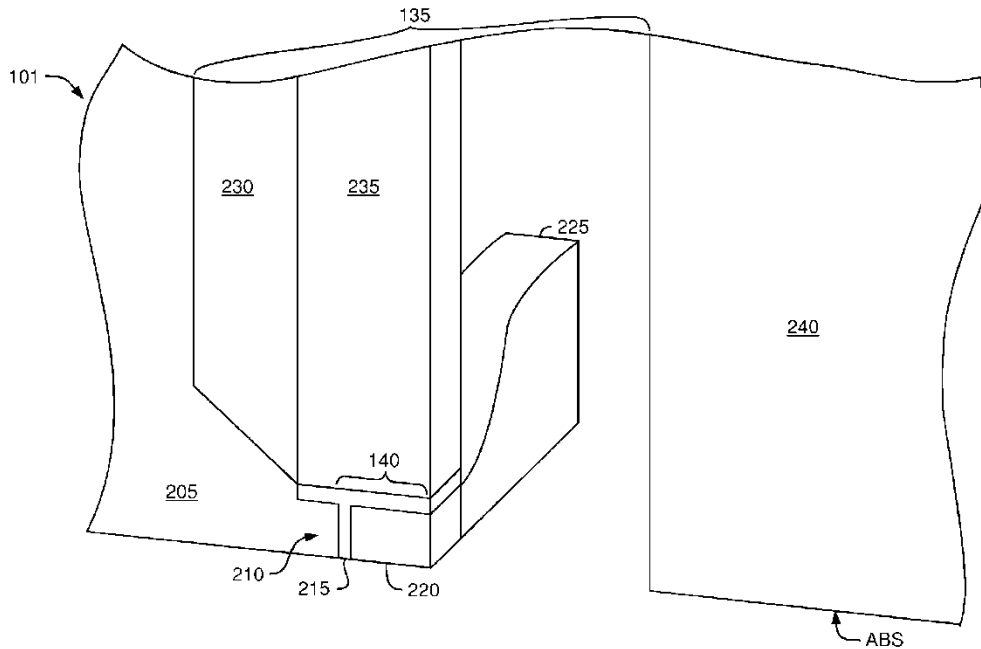
Primary Examiner — Muhammad N Edun

(74) *Attorney, Agent, or Firm* Patterson & Sheridan, I.T.P

(57) **ABSTRACT**

The presented embodiments generally relate to designing an antenna of an optical transducer (e.g., a near-field transducer or near-field optical source) that focuses the optical energy of a radiation source (e.g., a laser) onto a magnetic media, thereby heating the media. Specifically, the antenna is designed to wrap-around an aperture of the optical transducer such that at least a portion of the antenna is between a main pole of a write head and a surface of the aperture that faces the main pole. Moreover, the antenna may wrap-around the aperture such that it directly contacts the main pole.

20 Claims, 7 Drawing Sheets





US008498656B2

(12) **United States Patent**
Mujtaba et al.

(10) **Patent No.:** **US 8,498,656 B2**
(45) **Date of Patent:** **Jul. 30, 2013**

(54) **ELECTRONIC DEVICE WITH IDLE MODE ANTENNA SWITCHING**

(75) Inventors: **Syed A. Mujtaba**, Santa Clara, CA (US); **Kee-Bong Song**, Santa Clara, CA (US); **Youngjac Kim**, Cupertino, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 214 days.

(21) Appl. No.: **13/098,947**

(22) Filed: **May 2, 2011**

(65) **Prior Publication Data**

US 2012/0282982 A1 Nov. 8, 2012

(51) **Int. Cl.**
H04W 68/00 (2009.01)

(52) **U.S. Cl.**
USPC **455/458**

(58) **Field of Classification Search**
USPC 455/458
See application file for complete search history.

(56) **References Cited**

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Syed A. Mujtaba, U.S. Appl. No. 13/099,081, filed May 2, 2011.

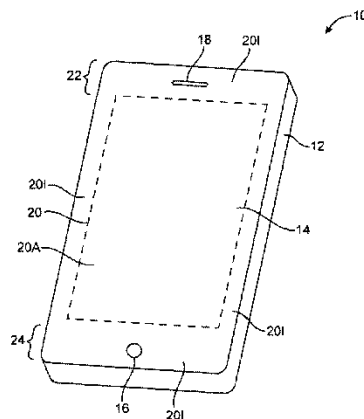
Primary Examiner — Nathan Mitchell

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; Jason Tsai

(57) **ABSTRACT**

Electronic devices may be provided that contain wireless communication circuitry. The wireless communication circuitry may include radio-frequency transceiver circuitry coupled to multiple antennas. An electronic device may alternate between a sleep mode and a wake mode. During wake mode, the electronic device may monitor a paging channel in a wireless network for incoming paging signals. The device may use a selected one of the multiple antennas in monitoring the paging channel. If received signal quality is satisfactory, the device may maintain use of the selected one of the multiple antennas for subsequent wake period monitoring of the paging channel. If received signal quality falls below a threshold or is otherwise indicated to not be satisfactory, the device may switch to use of a different one of the multiple antennas in monitoring the paging channel. Other criteria may also be used in controlling the switching between antennas for paging channel monitoring.

18 Claims, 4 Drawing Sheets





US008502734B2

(12) **United States Patent**
Motta Cruz et al.

(10) **Patent No.:** **US 8,502,734 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **PRINTED ANTENNA HAVING A DUAL-BEAM DIAGRAM**

(75) Inventors: **Eduardo Motta Cruz**, Saint Herblain (FR); **Jean Philippe Dessarce**, Palinges (FR); **Mohamed Himdi**, Rennes (FR); **Franck Colombel**, Montfort sur Meu (FR)

(73) Assignee: **Bouygues Telecom**, Boulogne Billancourt (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 787 days.

(21) Appl. No.: **12/362,335**

(22) Filed: **Jan. 29, 2009**

(65) **Prior Publication Data**
US 2009/0224980 A1 Sep. 10, 2009

(30) **Foreign Application Priority Data**
Jan. 30, 2008 (FR) 08 50581

(51) **Int. Cl.**
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
USPC **343/700 MS; 343/749**

(58) **Field of Classification Search**
USPC 343/700 MS
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Michael C Wimer

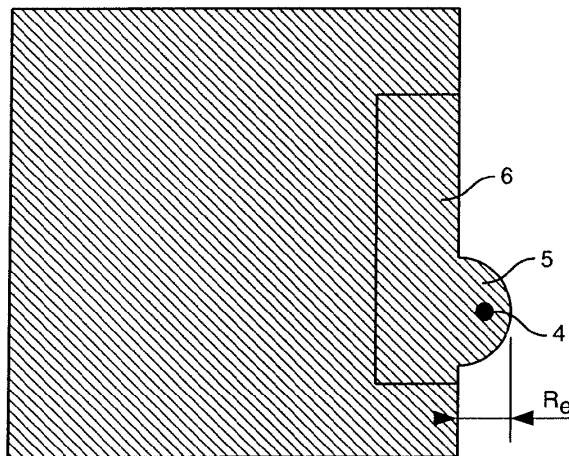
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Blakely Sokoloff Taylor & Zafman

(57) **ABSTRACT**

The invention relates to a printed antenna comprising a ground plane, a substrate stacked to the ground plane, a metal deposit made on the substrate in order to form therein a resonating patch (3), and a means of supplying to excite the resonating patch, characterized in that the patch has dimensions that are adapted for the patch to be able to radiate in both upper electromagnetic modes TM_{02} and TM_{20} , and in that the means of supplying makes it possible to excite the patch on an excitation point (4) arranged along the patch so that the patch resonates in a single of said upper electromagnetic modes, by inducing this way a dual-beam radiation diagram with, in the same plane orthogonal to the patch, two main misaligned and symmetric lobes in relation to the normal to the patch.

8 Claims, 6 Drawing Sheets





US008502737B2

(12) **United States Patent**
Kawata et al.

(10) **Patent No.:** **US 8,502,737 B2**

(45) **Date of Patent:** **Aug. 6, 2013**

(54) **COMMUNICATION DEVICE**

(56) **References Cited**

(75) Inventors: **Toshihiko Kawata**, Funabashi (JP);
Shinichi Nakada, Yamato (JP); **Masaki**
Noji, Kawasaki (JP)

(73) Assignee: **Kyocera Corporation**, Kyoto (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 740 days.

(21) Appl. No.: **12/294,873**

(22) PCT Filed: **Mar. 28, 2007**

(86) PCT No.: **PCT/JP2007/056641**

§ 371 (c)(1),
(2), (4) Date: **May 28, 2010**

(87) PCT Pub. No.: **WO2007/114165**

PCT Pub. Date: **Oct. 11, 2007**

(65) **Prior Publication Data**

US 2010/0231459 A1 Sep. 16, 2010

(30) **Foreign Application Priority Data**

Mar. 28, 2006 (JP) 2006-087466
Mar. 28, 2006 (JP) 2006-087467

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
USPC **343/702; 343/700 MS**

(58) **Field of Classification Search**
USPC **343/700 MS, 702**
See application file for complete search history.

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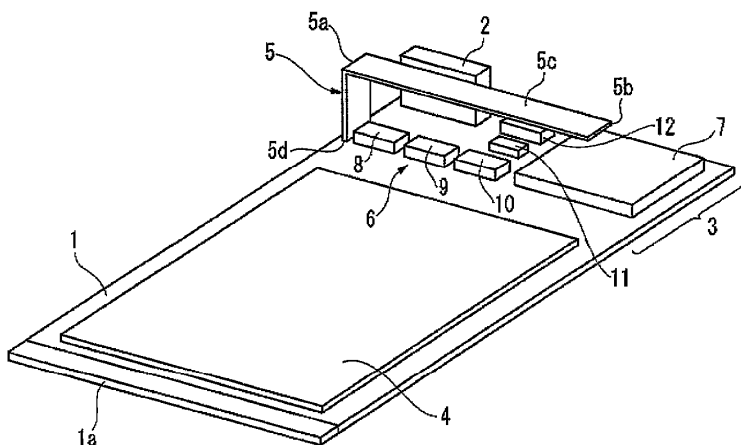
Primary Examiner — Tho G Phan

(74) Attorney, Agent, or Firm — DLA Piper LLP (US)

(57) **ABSTRACT**

A communication device which solves a new problem, that is, a power amplifier has oscillation caused by providing a conductive body which reduces the effects of the noise on a chip antenna, includes: a chip antenna which catches radio waves of a desired frequency; an RF circuit which is implemented on a printed wiring board and which converts received signals input from the chip antenna to a low frequency; a digital circuit which is implemented on the printed wiring board and which demodulates the received signals in a low frequency input from the RF circuit; a conductive body which is extended between the chip antenna and the digital circuit while being maintained at a certain height from the printed wiring board, and which has an end connected to a ground conductive body of the printed wiring board; and a radio wave absorption body which is attached to the conductive body.

6 Claims, 7 Drawing Sheets





US008502739B2

(12) **United States Patent**
Ollikainen et al.

(10) **Patent No.:** **US 8,502,739 B2**
(45) **Date of Patent:** ***Aug. 6, 2013**

(54) **ANTENNA ARRANGEMENT**

(56) **References Cited**

(75) Inventors: **Jani Ollikainen**, Helsinki (FI); **Harri A. Lasarov**, Espoo (FI); **Pekka Kilpi**, Helsinki (FI); **Jussi Rahola**, Espoo (FI); **Lassi Hyvonen**, Helsinki (FI); **Anssi Vanska**, Helsinki (FI); **Joonas Krogerus**, Espoo (FI)

(73) Assignee: **Nokia Corporation**, Espoo (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 592 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/665,479**

(22) PCT Filed: **Jun. 22, 2007**

(86) PCT No.: **PCT/IB2007/002780**

§ 371 (c)(1),

(2), (4) Date: **May 3, 2010**

(87) PCT Pub. No.: **WO2009/001158**

PCT Pub. Date: **Dec. 31, 2008**

(65) **Prior Publication Data**

US 2010/0220017 A1 Sep. 2, 2010

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
USPC **343/702**

(58) **Field of Classification Search**
USPC 343/702, 895, 753, 844, 793
See application file for complete search history.

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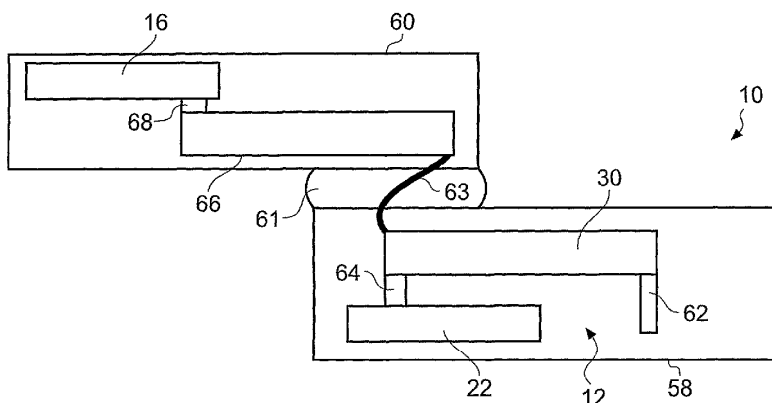
Primary Examiner — Huedung Mancuso

(74) Attorney, Agent, or Firm — Harrington & Smith

(57) **ABSTRACT**

An antenna arrangement including a ground plane having an electrical length; an antenna element positioned for coupling with the ground plane; a first conductive element; an interconnecting mechanism, connected to the ground plane and to the first conductive element, having a first configuration and a second configuration, wherein the ground plane has a first electrical length when the interconnecting mechanism is in the first configuration and a second electrical length, different to the first electrical length, when the interconnecting mechanism is in the second configuration.

20 Claims, 5 Drawing Sheets





US008502741B2

(12) **United States Patent**
Lin et al.

(10) **Patent No.:** **US 8,502,741 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **STRUCTURE FOR ADJUSTING AN EM WAVE PENETRATION RESPONSE AND ANTENNA STRUCTURE FOR ADJUSTING AN EM WAVE RADIATION CHARACTERISTIC**

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(75) Inventors: **Hung-Hsuan Lin**, Taipei (TW);
Chun-Yih Wu, Taichung (TW);
Ken-Huang Lin, Kaohsiung (TW);
Hsin-Lung Su, Kaohsiung (TW); **Yi-Jen Wang**, Tainan County (TW)

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(73) Assignees: **Industrial Technology Research Institute**, Hsinchu (TW); **National Sun Yat-sen University**, Kaohsiung (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 401 days.

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(21) Appl. No.: **13/012,805**

Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(22) Filed: **Jan. 25, 2011**

(65) **Prior Publication Data**

US 2012/0105295 A1 May 3, 2012

(30) **Foreign Application Priority Data**

Nov. 2, 2010 (TW) 99137645 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
USPC **343/702; 343/700 MS**

(58) **Field of Classification Search**
USPC 343/702, 700 MS, 841, 846
See application file for complete search history.

(57) **ABSTRACT**

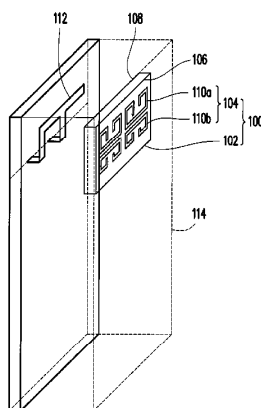
A structure for adjusting electromagnetic wave (EM wave) penetration response includes a plurality of structure units and a dielectric substrate with an upper surface and a lower surface. The structure units are disposed on the upper surface and/or the lower surface. The structure unit consists of metal lines or complementary slits so as to enable an EM wave penetration response of the structure to include a pass band and a stop band. The frequency of the stop band is higher than that of the pass band. If a distance between the structure and an object with a high dielectric constant is longer than a predetermined distance, the pass band covers a radiation frequency of an antenna. If the distance between the structure and the object with the high dielectric constant is within the predetermined distance, the stop band covers the radiation frequency of the antenna.

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16 Claims, 22 Drawing Sheets





US008502745B2

(12) **United States Patent**
Park et al.

(10) **Patent No.:** **US 8,502,745 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **ANTENNA APPARATUS**

(56) **References Cited**

(75) Inventors: **Se Hyun Park**, Suwon-si (KR); **Byung Tae Yoon**, Suwon-si (KR); **Dong-Jin Kim**, Seoul (KR); **Seong-Ook Park**, Daejeon (KR); **Rashid A. Bhatti**, Daejeon (KR); **Viet Anh Nguyen**, Daejeon (KR); **Mingoo Choi**, Daejeon (KR)

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(73) Assignee: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 877 days.

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(21) Appl. No.: **12/371,684**

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(22) Filed: **Feb. 16, 2009**

Primary Examiner — Dieu H Duong

(65) **Prior Publication Data**

US 2010/0045557 A1 Feb. 25, 2010

(74) *Attorney, Agent, or Firm* — NSIP Law

(30) **Foreign Application Priority Data**

Aug. 19, 2008 (KR) 10-2008-0081019

(57) **ABSTRACT**

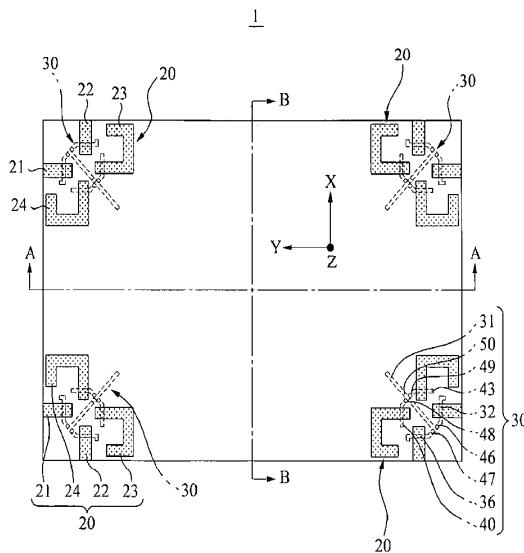
(51) **Int. Cl.**
H01Q 13/10 (2006.01)

An antenna apparatus that may be adapted to various environments. The antenna apparatus includes a radiation unit to transmit and receive in a 360° radius including a plurality of radiators, each radiator configured to radiate a main emission pattern in different direction; and a switch unit configured to selectively operate each of the plurality of radiators.

(52) **U.S. Cl.**
USPC **343/770**; 343/893; 343/867; 343/850

19 Claims, 6 Drawing Sheets

(58) **Field of Classification Search**
USPC 343/770, 876, 893, 850
See application file for complete search history.





US008502746B2

(12) **United States Patent
Huang**

(10) **Patent No.: US 8,502,746 B2**
(45) **Date of Patent: Aug. 6, 2013**

- (54) **PLANAR DIRECTIONAL ANTENNA**
- (75) Inventor: **Huan-Chu Huang**, Taoyuan County (TW)
- (73) Assignee: **HTC Corporation**, Taoyuan County (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 487 days.
- (21) Appl. No.: **12/618,795**
- (22) Filed: **Nov. 16, 2009**
- (65) **Prior Publication Data**
US 2011/0063187 A1 Mar. 17, 2011
- (30) **Foreign Application Priority Data**
Sep. 14, 2009 (TW) 98130911 A
- (51) **Int. Cl.**
H01Q 19/30 (2006.01)
H01Q 19/00 (2006.01)
H01Q 19/12 (2006.01)
- (52) **U.S. Cl.**
USPC **343/819**; 343/833; 343/840
- (58) **Field of Classification Search**
USPC 343/700 MS, 793, 818, 819, 833, 343/834, 840, 846
See application file for complete search history.

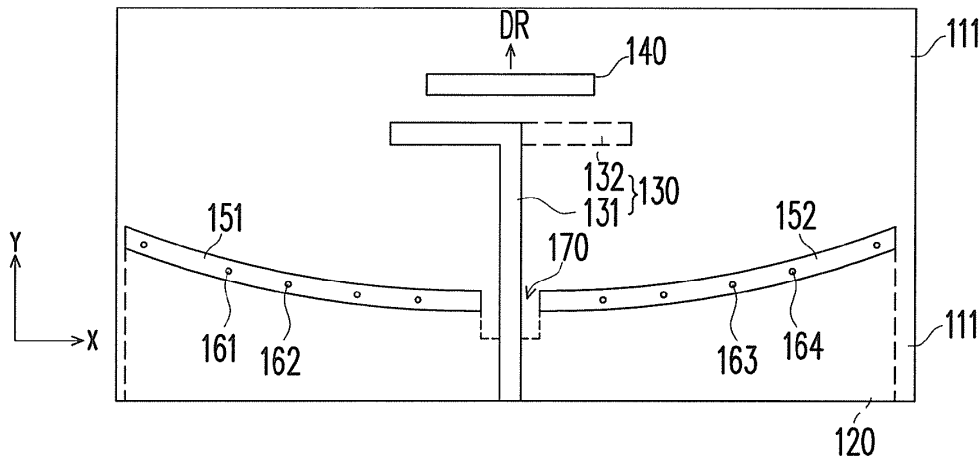
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Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(57) **ABSTRACT**

A planar directional antenna including a substrate, a metal layer, a master antenna, and an auxiliary antenna is provided. The substrate has a first surface and a second surface. The metal layer is disposed on the second surface of the substrate, and an upper edge of the metal layer forms a concave parabolic curve. The master antenna is disposed on the substrate and located within a predetermined range of the focus of the concave parabolic curve. The auxiliary antenna is disposed on the substrate and opposite to the master antenna so that the planar directional antenna generates a beam toward a radiation direction.

9 Claims, 6 Drawing Sheets





US008502747B2

(12) **United States Patent**
Chang et al.

(10) **Patent No.:** **US 8,502,747 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **DIPOLE ANTENNA ASSEMBLY**

(56) **References Cited**

(75) Inventors: **Sheng-Che Chang**, Tu-Cheng (TW);
Chang-Ching Lin, Tu-Cheng (TW);
Chun-Chieh Tseng, Tu-Cheng (TW);
Yun-Cheng Hou, Tu-Cheng (TW); **John**
Chow, Saratoga, CA (US)

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(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 331 days.

Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Ming Chieh Chang; Wei Te
Chung

(21) Appl. No.: **12/906,180**

(22) Filed: **Oct. 18, 2010**

(65) **Prior Publication Data**

US 2011/0279341 A1 Nov. 17, 2011

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

May 12, 2010 (TW) 099208859

A dipole antenna assembly (100, 200) includes a dipole
antenna (10, 30) and a feeding element (20, 40) connecting
with the dipole antenna. The dipole antenna includes a radiation
portion (12, 32), a ground portion (13, 33) and a circuit
(14, 34). The feeding element includes a central conductor
(21, 41) soldered on the radiation portion at a first position,
and a shielding layer (23, 43) soldered on the ground portion
at a second position. The circuit includes one end connecting
with the radiation portion at the first position, and another end
connecting with the ground position at the second position for
impedance matching.

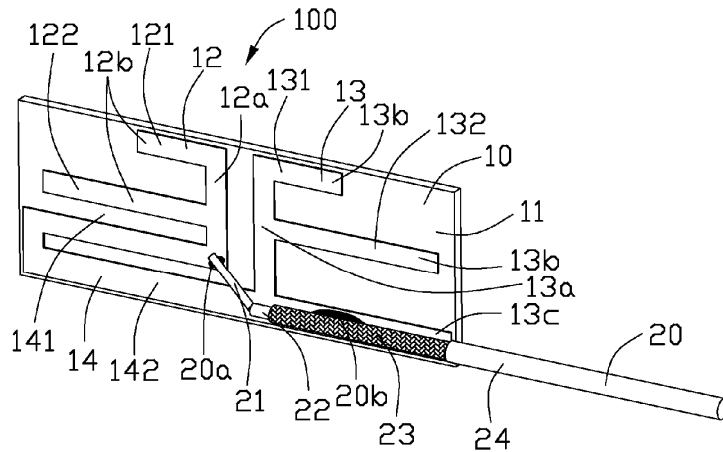
(51) **Int. Cl.**
H01Q 9/16 (2006.01)

(52) **U.S. Cl.**
USPC **343/822**; 343/795; 343/700 MS

(58) **Field of Classification Search**
USPC 343/820, 821, 822, 700 MS, 795,
343/79, 793

See application file for complete search history.

7 Claims, 6 Drawing Sheets





US008502748B2

(12) **United States Patent**
Liang et al.

(10) **Patent No.:** **US 8,502,748 B2**
(45) **Date of Patent:** **Aug. 6, 2013**

(54) **THREE-DIMENSIONAL DUAL-BAND ANTENNA**

(75) Inventors: **Mao-Tse Liang**, Hsinchu (TW);
Shih-Chieh Cheng, Tainan County (TW); **Kuo-Chang Lo**, Miaoli County (TW)

(73) Assignee: **Arcadyan Technology Corporation**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 349 days.

(21) Appl. No.: **12/870,298**

(22) Filed: **Aug. 27, 2010**

(65) **Prior Publication Data**
US 2011/0050523 A1 Mar. 3, 2011

(30) **Foreign Application Priority Data**
Aug. 28, 2009 (TW) 98129023 A

(51) **Int. Cl.**
H01Q 1/50 (2006.01)

(52) **U.S. Cl.**
USPC **343/860**; 343/702; 343/729; 343/792

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 770, 846, 820, 343/844, 850, 860, 893, 914
See application file for complete search history.

(56) **References Cited**

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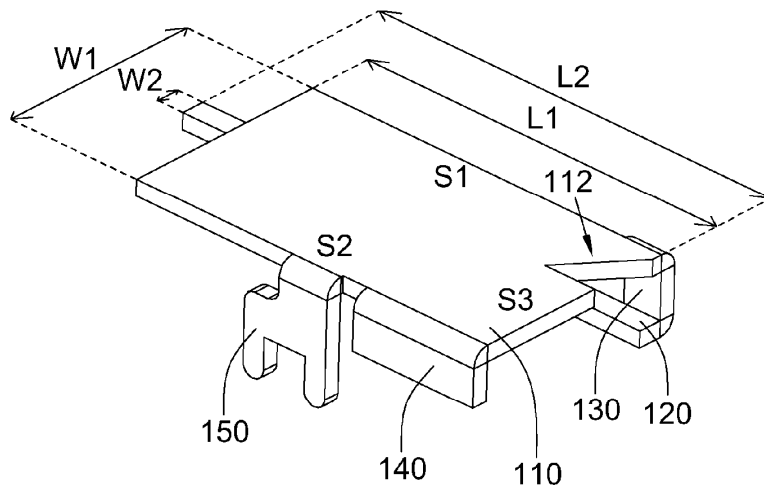
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Primary Examiner — Shawki Ismail
Assistant Examiner — Christopher Lo
(74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

(57) **ABSTRACT**

A three-dimensional dual-band antenna including a first radiation portion, a second radiation portion, a connection portion, an impedance matching portion and a feeding portion is provided. The second radiation portion is located under the radiation portion and parallel with the first radiation portion. The connection portion is connected to the first side of the first radiation portion and extended downward vertically, for connecting the first radiation portion and the second radiation portion. The impedance matching portion is connected to a second side of the first radiation portion and extended downward vertically. The first side and the second side are opposite. The feeding portion is connected to the second side and extended downward vertically. The feeding portion receives a feeding signal. The first and the second radiation portion are operated at the first and the second bandwidth respectively, wherein the second bandwidth is in higher frequency than the first bandwidth.

19 Claims, 8 Drawing Sheets





US008508416B2

(12) **United States Patent**
Chirila et al.

(10) **Patent No.:** **US 8,508,416 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

(54) **CAP ASSEMBLY**

(75) Inventors: **Laurian P. Chirila**, Irvine, CA (US);
Iain C. Roy, Mississauga (CA)
(73) Assignee: **Psion Inc.**, Mississauga, Ontario (CA)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 438 days.

(21) Appl. No.: **12/766,264**

(22) Filed: **Apr. 23, 2010**

(65) **Prior Publication Data**

US 2011/0260930 A1 Oct. 27, 2011

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
USPC **343/702; 343/841**

(58) **Field of Classification Search**
USPC 343/702, 718, 841, 872; 455/347, 455/348, 556.1, 556.2; 235/439, 454, 462.01, 235/462.45, 462.46, 462.47, 472.01, 472.02

See application file for complete search history.

(56) **References Cited**

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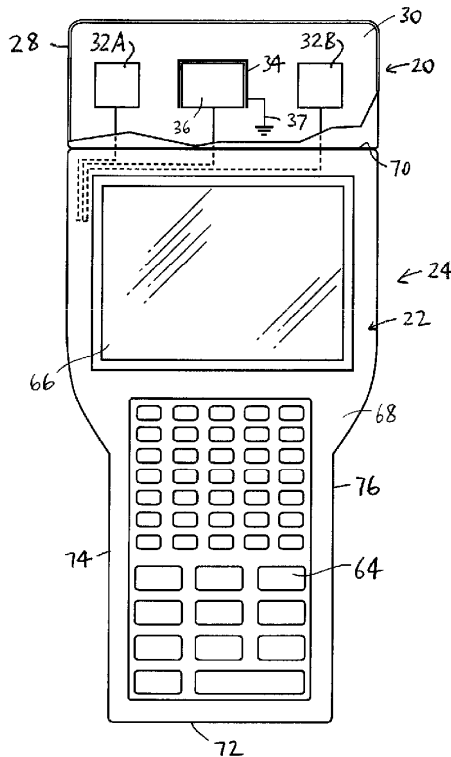
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Primary Examiner — Hoanganh Le

(57) **ABSTRACT**

A cap assembly attachable to a main housing of a handheld device. The cap assembly includes a cap body at least partially defining one or more cavities therein, and one or more WAN antennas receivable in the cavity. In addition, the cap assembly includes an electromagnetic shield receivable in the cavity for providing each WAN antenna with a predetermined electromagnetic environment in which the impedances of the WAN antenna and the electromagnetic shield are substantially matched.

20 Claims, 8 Drawing Sheets





US008508418B2

(12) **United States Patent**
Kough et al.

(10) **Patent No.:** **US 8,508,418 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

(54) **ANTENNAS FOR ELECTRONIC DEVICES WITH CONDUCTIVE HOUSING**

(75) Inventors: **Douglas B. Kough**, San Jose, CA (US);
Gregory A. Springer, Sunnyvale, CA (US);
Bing Chiang, Melbourne, FL (US);
Enrique Ayala Vazquez, Watsonville, CA (US);
Hao Xu, Cupertino, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/619,614**

(22) Filed: **Sep. 14, 2012**

(65) **Prior Publication Data**

US 2013/0009833 A1 Jan. 10, 2013

Related U.S. Application Data

(62) Division of application No. 12/490,286, filed on Jun. 23, 2009, now Pat. No. 8,269,675.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
USPC **343/702; 343/767**

(58) **Field of Classification Search**
USPC **343/702, 767, 770**
See application file for complete search history.

(56) **References Cited**

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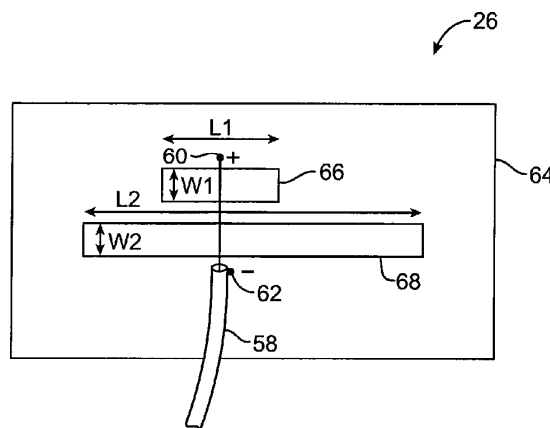
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Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; David C. Kellogg

(57) **ABSTRACT**

An electronic device may be provided with a conductive housing. The conductive housing may be formed from a metal. Slots may be formed in the housing. The slots may serve as an antenna and may be fed using an antenna feed structure within the electronic device housing. The electronic device may have a frame to which housing structures are attached and may have a stand or other support structure. The frame may be used to mount a display, to support housing walls, to support clutch barrel structures, etc. The slots may be formed in the frame or in a space between the frame and the housing walls. The slots or other antenna structures may also be formed in the stand. Multiple slots may be used together to support operations in two or more communications bands. There may be multiple dual slot antennas in the electronic device.

18 Claims, 17 Drawing Sheets





US008508420B2

(12) **United States Patent**
Fujieda et al.

(10) **Patent No.:** **US 8,508,420 B2**
(45) **Date of Patent:** ***Aug. 13, 2013**

- (54) **ANTENNA DEVICE AND WIRELESS COMMUNICATION APPARATUS**
- (75) Inventors: **Shigeyuki Fujieda**, Hakusan (JP);
Kazunari Kawahata, Yokohama (JP);
Kenichi Ishizuka, Yokohama (JP)
- (73) Assignee: **Murata Manufacturing Co., Ltd.**,
Kyoto (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 133 days.

This patent is subject to a terminal disclaimer.

- (21) Appl. No.: **12/352,888**
- (22) Filed: **Jan. 13, 2009**
- (65) **Prior Publication Data**
US 2009/0115674 A1 May 7, 2009
- Related U.S. Application Data**
- (63) Continuation of application No. PCT/JP2007/058312, filed on Apr. 17, 2007.
- (30) **Foreign Application Priority Data**
Jul. 13, 2006 (JP) 2006-192433

- (51) **Int. Cl.**
H01Q 9/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)
H01Q 1/38 (2006.01)
- (52) **U.S. Cl.**
USPC **343/745**; 343/702; 343/750; 343/826;
343/853; 343/700 MS
- (58) **Field of Classification Search**
USPC 343/702, 745, 750, 826, 853, 700 MS
See application file for complete search history.

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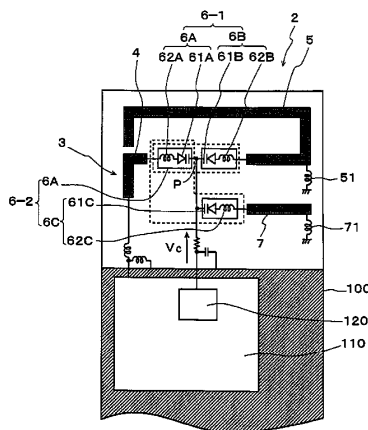
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Primary Examiner — Jacob Y Choi
Assistant Examiner — Graham Smith
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna device and a wireless communication apparatus that are capable of obtaining a plurality of resonant frequencies and varying the plurality of resonant frequencies over a wide range are provided. A first antenna unit of an antenna device includes a feed electrode, a first radiation electrode, and a first frequency-variable circuit. The first frequency-variable circuit includes first and second reactance circuits each including a variable-capacitance diode. A control voltage is applied to the first frequency-variable circuit, and the resonant frequency of the first antenna unit can thus be varied. A second antenna unit includes the feed electrode, a second radiation electrode, and a second frequency-variable circuit. The second frequency-variable circuit includes first and third reactance circuits each including a variable-capacitance diode. A control voltage is applied to the second frequency-variable circuit, and the resonant frequency of the second antenna unit can thus be varied.

6 Claims, 9 Drawing Sheets





US008508423B2

(12) **United States Patent**
Suetsuna et al.

(10) **Patent No.:** **US 8,508,423 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

(54) **ANTENNA DEVICE**

(75) Inventors: **Tomohiro Suetsuna**, Kanagawa (JP);
Makoto Higaki, Kanagawa (JP);
Kouichi Harada, Tokyo (JP); **Seichi**
Suenaga, Kanagawa (JP); **Mitsuru**
Ishibashi, Kanagawa (JP); **Maki**
Yonetsu, Tokyo (JP)

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U.S. Appl. No. 12/623,749, filed Nov. 23, 2009, Inoue, et al.
U.S. Appl. No. 12/351,235, filed Jan. 9, 2009, Makoto Higaki, et al.

(73) Assignee: **Kabushiki Kaisha Toshiba**, Tokyo (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1043 days.

(21) Appl. No.: **12/410,768**

(22) Filed: **Mar. 25, 2009**

(65) **Prior Publication Data**
US 2009/0295662 A1 Dec. 3, 2009

(30) **Foreign Application Priority Data**
May 30, 2008 (JP) 2008-141856

(51) **Int. Cl.**
H01Q 1/00 (2006.01)
H01Q 19/10 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
USPC **343/787**; 343/818; 343/700 MS

(58) **Field of Classification Search**
USPC 343/818
See application file for complete search history.

(56) **References Cited**
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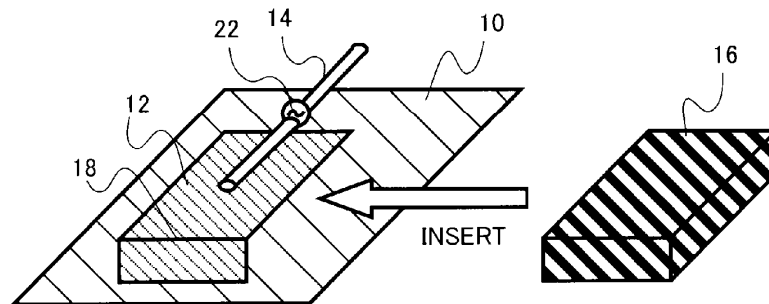
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Primary Examiner — Jacob Y Choi
Assistant Examiner — Graham Smith
(74) *Attorney, Agent, or Firm* — Oblon, Spivak, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

The present invention provides a small antenna device realizing both miniaturization including lower profile and a broader band in a frequency band of hundreds MHz to 5 GHz and which can be mounted on a small device such as a cellular phone. An antenna device includes: a finite ground plane; a rectangular conductor plate provided above the finite ground plane, whose one side is connected to the finite ground plane, and having a bent portion substantially parallel with the one side; an antenna disposed substantially parallel with the finite ground plane above the finite ground plane, extending in a direction substantially perpendicular to the one side, and having a feeding point positioned near the other side facing the one side of the rectangular conductor plate; and a magnetic material provided in at least a part of space between the finite ground plane and the antenna.

20 Claims, 7 Drawing Sheets





US008508425B2

(12) **United States Patent**
Aizawa

(10) **Patent No.:** **US 8,508,425 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

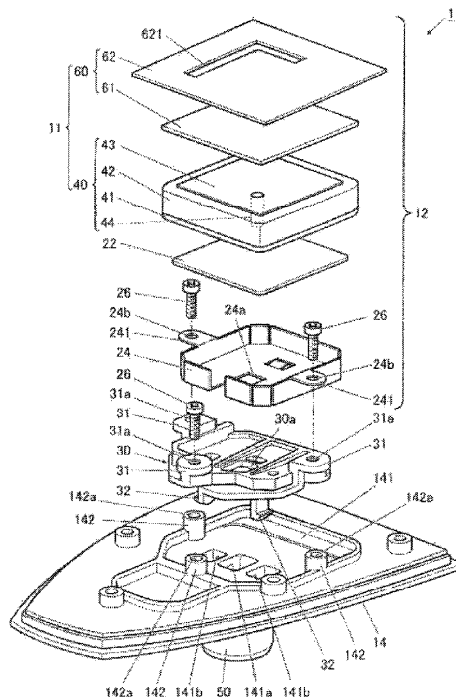
- (54) **PATCH ANTENNA, ANTENNA UNIT AND ANTENNA APPARATUS**
- (75) Inventor: **Toshiaki Aizawa**, Tokyo (JP)
- (73) Assignee: **Mitsumi Electric, Co., Ltd.**, Tokyo (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 321 days.
- (21) Appl. No.: **13/075,328**
- (22) Filed: **Mar. 30, 2011**
- (65) **Prior Publication Data**
US 2011/0241961 A1 Oct. 6, 2011
- (30) **Foreign Application Priority Data**
Mar. 31, 2010 (JP) 2010-080177
- (51) **Int. Cl.**
H01Q 19/06 (2006.01)
- (52) **U.S. Cl.**
USPC **343/833; 343/700**
- (58) **Field of Classification Search**
USPC 343/833, 834, 841, 867, 872, 700, 343/702, 711, 712, 713, 715, 725, 727, 728, 343/729, 742; 455/344, 374
See application file for complete search history.

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- Primary Examiner* — Karl D Frech
(74) *Attorney, Agent, or Firm* — Washida & Associates

(57) **ABSTRACT**

Provided is a patch antenna, an antenna unit and an antenna apparatus that can increase the directional gain of a patch antenna at a high angle of elevation and that can make the directional gain of a patch antenna at a given angle of elevation uniform at all azimuth angles. Patch antenna **11** has patch antenna main body **40** having antenna electrode **43** on its top surface, and a waveguide **60** mounted on the top surface of patch antenna main body **40**. Waveguide **60** has top plate **62** having a larger flat surface than patch antenna main body **40** and having L-shaped slot **621** on the flat surface, and spacer **61** provided between the top surface of patch antenna main body **40** and top plate **62** and separating antenna electrode **43** and top plate **62** a predetermined distance apart.

3 Claims, 5 Drawing Sheets





US008508426B2

(12) **United States Patent**
Honda et al.

(10) **Patent No.:** **US 8,508,426 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

(54) **VARIABLE DIRECTIONAL ANTENNA**

(75) Inventors: **Atsushi Honda**, Kawasaki (JP); **Ichirou Ida**, Kawasaki (JP); **Yasuyuki Oishi**, Kawasaki (JP)

(73) Assignee: **Fujitsu Limited**, Kawasaki (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 270 days.

(21) Appl. No.: **12/698,703**

(22) Filed: **Feb. 2, 2010**

(65) **Prior Publication Data**

US 2010/0182214 A1 Jul. 22, 2010

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2007/000860, filed on Aug. 9, 2007.

(51) **Int. Cl.**
H01Q 19/10 (2006.01)
H01Q 1/38 (2006.01)
H01Q 19/00 (2006.01)

(52) **U.S. Cl.**
USPC **343/834**; 343/700 MS; 343/833

(58) **Field of Classification Search**
USPC 343/700 MS, 833, 834
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Robert Karacsony

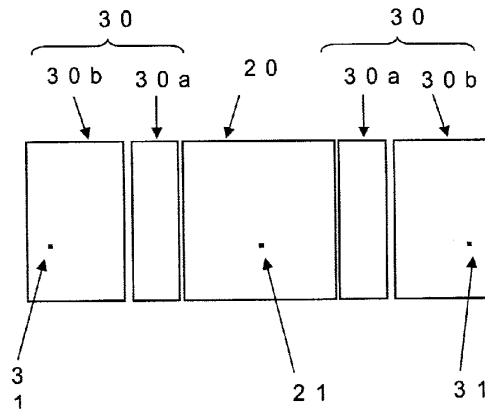
Assistant Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — Smith, Gambrell & Russell, LLP

(57) **ABSTRACT**

A variable directional antenna by means of a microstrip antenna and reactance change. The variable directional antenna has a structure to reduce sidelobes occurring when an element interval is reduced, and is structured in a three-element plane, having a feeding element and non-feeding elements provided at both sides of the feeding element. Each of the non-feeding elements provided at both sides of the feeding element has two split non-feeding elements two-divided into sizes of 1:2 in the lateral direction. The split non-feeding element divided into the size 1 is provided closer to the feeding element, and a reactance variable part is connected with the split non-feeding element divided into the size of 2. Alternatively, each of the non-feeding elements provided at both sides of the feeding element has two split non-feeding elements two-divided into sizes of 2:1 in the lateral direction. The split non-feeding element divided into the size 2 is provided closer to the feeding element, and the reactance variable part is connected either with the split non-feeding element divided into the size of 2 or the split non-feeding element divided into the size 1.

8 Claims, 11 Drawing Sheets





US008508428B2

(12) **United States Patent**
Ollikainen et al.

(10) **Patent No.:** **US 8,508,428 B2**
(45) **Date of Patent:** **Aug. 13, 2013**

- (54) **ANTENNA ARRANGEMENT**
- (75) Inventors: **Jani Ollikainen**, Helsinki (FI); **Juha Villanen**, Espoo (FI); **Jari Petteri Holopainen**, Espoo (FI); **Clemens Icheln**, Espoo (FI); **Pertti Vainikainen**, Helsinki (FI)
- (73) Assignee: **Nokia Corporation**, Espoo (FI)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 912 days.
- (21) Appl. No.: **12/532,179**
- (22) PCT Filed: **Mar. 30, 2007**
- (86) PCT No.: **PCT/IB2007/002081**
§ 371 (c)(1),
(2), (4) Date: **Nov. 23, 2009**
- (87) PCT Pub. No.: **WO2008/120038**
PCT Pub. Date: **Oct. 9, 2008**
- (65) **Prior Publication Data**
US 2010/0073253 A1 Mar. 25, 2010
- (51) **Int. Cl.**
H01Q 9/00 (2006.01)
H01Q 1/48 (2006.01)

- (52) **U.S. Cl.**
USPC **343/850**; 343/702; 343/846
- (58) **Field of Classification Search**
USPC 343/700 MS, 702, 846, 848, 850, 343/860
See application file for complete search history.

- (56) **References Cited**
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- (57) **ABSTRACT**
An antenna arrangement including a partitioned ground plane including at least a first part and a second part that are interconnected by a component having a predetermined impedance; and an inductive coupling element positioned adjacent the component.

20 Claims, 5 Drawing Sheets

